COMPUTATIONS FOR PREDICTING MATERIAL PROPERTIES OF TRACHEAL SMOOTH MUSCLE TISSUE

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Smooth muscle tissue can be found in the intestines, blood vessels, bladders, digestive tract, uterus and other organs. Tracheal smooth muscle tissue and other soft tissues exhibit non-linear material properties that are strain dependent, viscoelastic and anisotropic. A challenging goal is to establish the relationship between microstructure, structural morphology and the mechanical properties. At this time, there is no such relationship, nor do the experimental data exist to establish such a relationship for smooth muscle tissues.

Like any other biological tissue, smooth muscle exhibits anisotropic properties due to distinct microstructural orientation in the longitudinal and transverse directions. Since it is very difficult to experimentally measure the anisotropic properties of the smooth muscle tissue without mechanical constraints on its function, an indirect method is proposed in this study to obtain both the longitudinal and radial mechanical properties. Through an iterative process, the anisotropic properties are estimated by matching the area changes obtained from the finite element analysis to those derived from the experiments. We also investigated non-linear material models to represent stress-strain behavior of a tracheal smooth muscle tissue. Finite element analysis was carried out to predict the contraction of the muscle and the cross-section area change based on experimental data. A good representation of a hyperelastic non-linear material model is developed and the results of stress-strain behavior are presented from the finite element analysis. The results obtained indicate that the approach and the non-linear material models developed are useful for describing the stress-strain characteristics of smooth muscle tissues.

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